Notice No.1

Rules and Regulations for the Classification of Ships, July 2016

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Issue date: September 2016

Amendments to	**Effective date**
Part 3, Chapter 6, Section 7	1 July 2016

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Part 3, Chapter 6
Aft End Structure

■ *Section 7*
Sternframes and appendages

7.1 General

~~7.1.3 Castings and forgings are to comply with the requirements of *Ch 4 Steel Castings* and *Ch 5 Steel Forgings* of the Rules for Materials respectively.~~

~~7.1.4~~ 7.1.3 Cast sternframes, rudder horns, shaft brackets and solepieces are to be manufactured from special grade material. Cast bossings can be manufactured from normal grade material, *see Ch 4, 2 Castings for ship and other structural applications* of the Rules for Materials.

~~7.1.5~~ 7.1.4 Sternframes, rudder horns, shaft brackets, etc. are to be effectively integrated into the ship's structure, and their design is to be such as to facilitate this.

7.2 Sternframes

~~7.2.4 The sole piece is to be dimensioned such that the stresses do not exceed the permissible stresses given in *Table 6.7.2 Permissible stresses for sole pieces*.~~

Notes on the renumbering of Figures and Tables
Figure 6.7.3 Rudder axle has been renumbered 6.7.4
Figure 6.7.4 Rudder post for twin screw ships has been renumbered 6.7.5
Figure 6.7.5 Double arm shaft bracket has been renumbered 6.7.10
Figure 6.7.6 Solepieces has been renumbered 6.7.3
Figure 6.7.7 Rudder horn has been deleted
Figure 6.7.8 Propeller clearances has been renumbered 6.7.11
New Figures 6.7.6 to 6.7.9 have been inserted as shown
Table 6.7.2 Permissible stresses for sole pieces has been deleted
Table 6.7.3 Permissible stresses for rudder horns has been deleted
Table 6.7.4 Rudder coefficient k_R has been renumbered 6.7.2
New Tables 6.7.3 to 6.7.6 have been inserted as shown

Table 6.7.1 Sternframes

Item	Parameter	Requirement		
(1) Propeller posts *see* Notes 1 and 2		Cast steel, *see Figure 6.7.1 Propeller posts (a)*	Forged steel, *see Figure 6.7.1 Propeller posts (b)*	Fabricated mild steel, *see Figure 6.7.1 Propeller posts (c)*
	l	$165\sqrt{T}$ mm	-	$200\sqrt{T}$ mm
	r	$20\sqrt{T}$ mm	-	$18\sqrt{T}$ mm
	t_w	$8\sqrt{T}$ mm (need not exceed 38)	(need not exceed 30)	$6\sqrt{T}$ mm
	t_1	$12\sqrt{T}$ mm (min. 19)	-	$12\sqrt{T}$ mm
	t_2	$16\sqrt{T}$ mm (min. 25)	-	-
	w	$115\sqrt{T}$ mm	$40\sqrt{T}$ mm	$140\sqrt{T}$ mm
	A	-	$(10 + 0{,}5L)T$ cm^2 where $L \leq 60$ m $40T$ cm^2 where $L > 60$ m	-
(2) Propeller boss, *see* Note 3 and *Figure 6.7.2 Propeller boss*	t_b	$(0{,}1\delta_{TS} + 56)$ mm, but need not exceed $0{,}3\delta_{TS}$		
(3) Rudder posts or axles		Single screw with integral solepiece, ~~*see Figure 6.7.6 Solepieces*~~ *see Figure 6.7.3 Solepieces (a)*	Single screw with bolted rudder axle, *see* ~~*Figure 6.7.3 Rudder axle*~~ *Figure 6.7.4 Rudder axle*	Twin screw, integral with hull, *see* ~~*Figure 6.7.4 Rudder post for twin screw ships*~~ *Figure 6.7.5 Rudder post for twin screw ships*
	n	-	6 (*see* Note 4)	-
	r	-	-	$20\sqrt{T}$ mm
	r_b	-	δ_A mm	-
	t_F	-	δ_B mm	-
	t_1	-	-	$12\sqrt{T}$ mm
	t_2	-	-	$15\sqrt{T}$ mm
	t_3	-	-	$18\sqrt{T}$ mm
	w	-	-	$120\sqrt{T}$ mm
	z_{PB1}, z_{PB2}	-	$1{,}2\delta_{PL2}$ mm	-
	Z_T	~~$0{,}147\left(\frac{k_R}{0{,}248}\right)^3 A_R c_2 b (V_o + 3)^2$~~ $0{,}147\left(\frac{k_R}{0{,}248}\right)^3 A_R K_2 b (V_o + 3)^2$ cm^3	-	-
	δ_A	-	$(25T + 76)$ mm but need not exceed $0{,}9\delta_{PL2}$	-
	δ_b	-	$6{,}25T + 19$ mm or $0{,}225\delta_{PL2}$ mm whichever is the greater	-
	δ_{PL1}, δ_{PL2} bearing pressure and pintle clearance	-	As for rudder pintles (*see Table 13.2.12 Pintle requirements* in *Chapter 13*)	-
~~(4) Solepieces, *see* Notes 5, 6 and 7~~	~~Z_T~~ ~~Z_v~~ ~~A_s~~	~~$0{,}0125\ M_b\ K_o$~~ ~~$0{,}5\ Z_T$~~ ~~$0{,}02\ B_1\ K_o$~~		
Symbols				

L, *T* as defined in *Pt 3, Ch 6, 1.4 Symbols and definitions 1.4.1*
~~*a, b, c* = distances, in metres, as shown in *Figure 6.7.6 Solepieces*~~
b = length of the rudder post or axle, in m, as defined in *Figure 6.7.3 Solepieces*
K_2 = rudder profile coefficient, as defined in *Table 13.2.2 Rudder profiles* in *Chapter 13*
~~B_1 = *see Table 6.7.2 Permissible stresses for sole pieces*~~
~~c_2 = rudder profile coefficient, as given by *Table 13.2.2 Rudder profiles* in *Chapter 13*~~
n = number of bolts in palm coupling
r_b = mean distance of bolt centres from centre of palm, in mm
t_b = finished thickness of boss, in mm
~~M_B = *see Table 6.7.2 Permissible stresses for sole pieces*~~
A = cross-sectional area of forged steel propeller post, in cm^2
A_R = rudder area, in m^2
k_R = rudder coefficient, ~~as given by *Table 6.7.4 Rudder coefficient k_R*~~ as defined in *Table 6.7.2 Rudder coefficient k_R*
~~*V*~~ V_o = maximum service speed, in knots, with the ship in the loaded condition
Z_T = section modulus against transverse bending, in cm^3
~~Z_v = section modulus against vertical bending, in cm^3~~
δ_b = diameter of coupling bolts, in mm

δ_{TS} = diameter of tail shaft, in mm
~~K_θ = as defined in *Pt 3, Ch 6, 7.3 Rudder horns 7.3.3*~~
~~A_s = sectional area, in mm^2~~

Note *1*. Where scantlings and proportions of the propeller post differ from those shown in Item (1), the section modulus about the longitudinal axis of the proposed section normal to the post is to be equivalent to that with Rule scantlings. *t* is to be not less than $8\sqrt{T}$ (minimum of 19 mm for cast steel sternframes) or as required by *Pt 3, Ch 6, 3.4 Side shell and sheer strake 3.4.2*, whichever is the greater.

Note *2.* On sternframes without solepieces, the modulus of the post below the propeller boss, about the longitudinal axis may be gradually reduced to not less than 85% of that required by Note 1, subject to the same thickness limitations.

Note *3*. In fabricated sternframes the connection of the propeller post to the boss is to be by full penetration welds.

Note *4*. If more than six bolts are fitted, the arrangements are to provide equivalent strength.

~~**Note** *5*. In fabricated solepieces, transverse webs are to be fitted spaced not more than 760 mm apart. Where the breadth of the solepiece exceeds 900 mm, a centreline vertical web is also to be fitted.~~

~~**Note** *6*. Solepieces supporting fixed or movable nozzles will be specially considered, *see Pt 3, Ch 13, 3.2 Nozzle structure*.~~

~~**Note** *7*. For dredging and reclamation craft classed 'A1 protected waters service', the scantlings of an ‘open’ type solepiece are to be such that:~~
~~(a) $Z_T = 0{,}625 Z_T$~~
~~(b) The cross-sectional area is not less than 18 cm^2~~
~~(c) The depth is not less than two-thirds of the width at any point.~~

7.3 Sole pieces

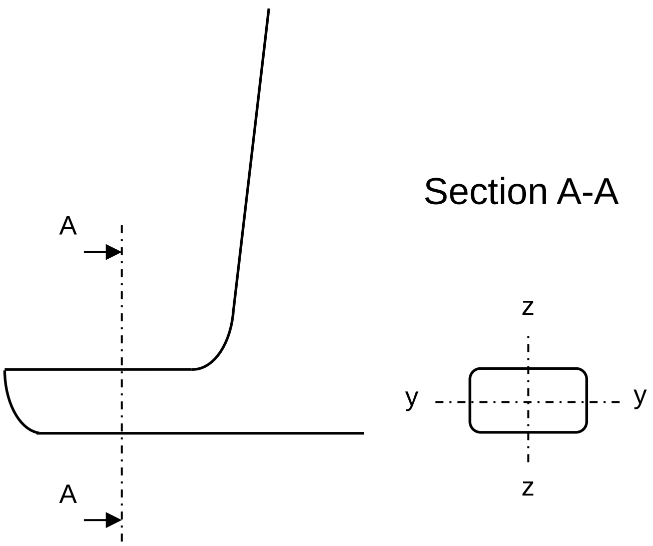

Figure 6.7.6 Solepiece

7.3.1 The scantlings of sole pieces are to be not less than those required by *Table 6.7.3 Sole pieces scantlings*:

Table 6.7.3 Sole pieces scantlings

Item, *see Figure 6.7.6 Solepiece*	Minimum requirement
Section modulus about the vertical (z)-axis, Z_z	$Z_z = \dfrac{M_b k}{80}$ cm^3
Section modulus about the transverse (y)-axis, Z_y	$Z_y = 0{,}5 Z_z$ cm^3
Section area, A_s	$A_s = \dfrac{B_1 k}{48}$ mm^2
Symbols	
M_b = bending moment, in Nm, at the section considered = $B_1 x$ x = distance, in m, from centre of rudder stock to section under consideration k = as defined in *Table 13.2.1 Rudder material factor, k* B_1 = supporting force in the pintle bearing, in N = 0,5 C_R C_R = as defined in *Ch 13,2 Rudders*	
Note *1*. For dredging and reclamation craft classed 'A1 protected waters service', the scantlings of an ‘open’ type solepiece are to be such that: (a) $Z_z = 0{,}625 Z_z$ (b) The cross-sectional area is not less than 18 cm^2 (c) The depth is not less than two-thirds of the width at any point. **Note** *2*. In fabricated solepieces, transverse webs are to be fitted spaced not more than 760 mm apart. Where the breadth of the solepiece exceeds 900 mm, a centreline vertical web is also to be fitted. **Note** *3*. Solepieces supporting fixed or movable nozzles will be specially considered, *see Pt 3,Ch 13, 3.2 Nozzle structure*.	

7.3.2 The solepiece is to be dimensioned such that the stresses do not exceed the permissible stresses given in *Table 6.7.4 Permissible stresses for solepieces*.

Table 6.7.4 Permissible stresses for solepieces

Mode	Permissible stress
(1) Equivalent stress	$\frac{115}{k}$ N/mm^2
Symbols	

σ_e = equivalent stress

= $\sqrt{\sigma_b^2 + 3\tau_T^2}$ N/mm^2

σ_b = bending stress

= $\frac{M_b}{Z_Z}$ N/mm^2

τ_T = shear stress

= $\frac{B_1}{A_S}$ N/mm^2

k = as defined in *Table 13.2.1 Rudder material factor, k*

~~**7.3 Rudder horns**~~

~~7.3.1 Rudder horns supporting semi-spade type rudders are to be efficiently integrated into the main hull structure, and additional web frames or side transverses may be required in the 'tween deck over.~~

~~7.3.2 The shell plating is to be increased in thickness in way of the horn. Where the horn plating is radiused into the shell plating, the radius at the shell connection is to be not less than:~~
~~r = (150 + 0,8L) mm~~

~~7.3.3 The scantlings of the rudder horn are to be such that the section modulus against transverse bending at any section is not less than:~~

~~$Z_T = 0{,}015 M_B K_o$ cm^3~~

~~where~~

~~M_B = bending moment~~
~~= $B_{1L}\, z$ Nm~~
~~B_{1L} = as calculated in *Table 13.2.12 Pintle requirements*~~
~~z = *see Fig. 6.7.7 Rudder horn*~~
~~K_o = k_o *see Table 13.2.1 Rudder material factor, k* for cast steel~~
~~K_o = k = 1,0 for fabricated mild steels~~
~~= k = 0,78 for high tensile steels with yield stress~~
~~σ_o = 315 N/mm^2~~
~~= k = 0,72 for high tensile steels with yield stress~~
~~σ_o = 355 N/mm^2.~~

~~7.3.4 The rudder horn is to be dimensioned such that the stresses do not exceed the permissible stresses given in *Table 6.7.3 Permissible stresses for rudder horns*.~~

~~**Table 6.7.2 Permissible stresses for solepieces**~~

~~Mode~~	~~Permissible stress~~
~~(2) Equivalent stress~~	~~$115/K_0$ N/mm^2 ($11{,}7/K_0$ kgf/mm^2)~~
~~Symbols~~	

~~σ_e = equivalent stress~~

~~= $\sqrt{\sigma_b^2 + 3\tau_T^2}$ N/mm^2~~

~~σ_b = bending stress~~

~~= $\frac{M_B}{Z_T}$ N/mm^2~~

~~τ_T = shear stress~~

~~= $\frac{B_1}{A_S}$ N/mm^2~~

~~K_o = as defined in *Pt 3, Ch 6, 7.3 Rudder horns 7.3.3*~~
~~M_B = bending moment, in Nm, at the section considered~~
~~= B_1 x~~
~~B_1 = supporting force, in N, in pintle bearing~~
~~= $0{,}5P_L$~~
~~P_L = rudder force, in N, as calculated in Ch 13,2~~
~~x = distance, in metres, from centre of rudder stock to section under consideration~~
~~Z_T = *see Table 6.7.1 Sternframes(4)*~~
~~A_s = sectional area, in mm^2, of solepiece~~

~~Table 6.7.3 Permissible stresses for rudder horns~~

~~Mode~~	~~Permissible stress~~	
(1) Shear stress	$48/K_0$ N/mm^2	($4,9/K_0$ kgf/mm^2)
(2) Equivalent stress	$120/K_0$ N/mm^2	($12/K_0$ kgf/mm^2)

Symbols

σ_e = equivalent stress

= $\sqrt{\sigma_b{}^2 + 3\left(\tau^2 + \tau_T{}^2\right)}$ N/mm^2

σ_b = bending stress

= $\dfrac{M_B}{Z_T}$ N/mm^2

τ = shear stress

= $\dfrac{B_{1L}}{A_h}$ N/mm^2

τ_T = torsional stress

= $\dfrac{10^3 M_T}{2 A_T t_h}$ N/mm^2

A_h = effective shear area, in mm^2, of rudder horn in y-direction
A_T = area in the horizontal section enclosed by the rudder horn, in mm^2
B_{1L} = as calculated in *Table 13.2.12 Pintle requirements*
K_o = as defined in 7.3.3
M_B = bending moment, in Nm, at the section considered
= B_{1L} z
M_T = torsional moment at the section considered, in Nm
= B_{1L} e
t_h = plate thickness of rudder horn, in mm
e = *see Figure 6.7.7 Rudder horn*
z = *see Figure 6.7.7 Rudder horn*
~~Z_T = *see Pt 3, Ch 6, 7.3 Rudder horns 7.3.3*~~

7.4 Rudder horns

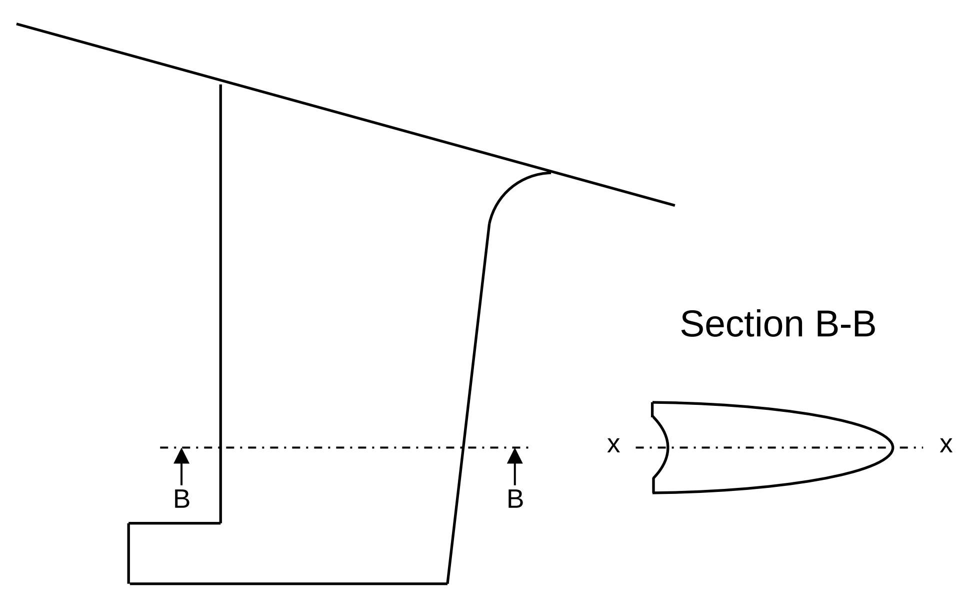

Figure 6.7.7 Rudder horn

7.4.1 Rudder horns are to be effectively integrated into the main hull structure.

7.4.2 The rudder horn side plating should be carried through the ship's bottom shell plating and aligned with primary members. Brackets or stringers are to be fitted on the inside of the rudder horn to align with the ship's adjoining bottom shell plating, *see Figure 6.7.8 Rudder horn integration*.

7.4.3 A number of transverse webs of the rudder horn should be carried through the ship's bottom shell up to the inner bottom or bottom deck. These rudder horn transverse webs should be fitted in line with strengthened plate floors.

7.4.4 Where practicable the rudder horn should be connected to the ship's centreline bulkhead.

7.4.5 Scallops in way of the connection between the rudder horn transverse webs and the ship's adjoining bottom shell plating are to be avoided.

7.4.6 The weld at the connection between the rudder horn plating and the ship's bottom shell is to be full penetration. The welding radius is to be as large as practicable and may be obtained by grinding.

7.4.7 When the connection between the rudder horn and the hull structure is designed as a curved transition into the hull plating, special consideration is to be given to the effectiveness of the rudder horn plate bending and to the stresses in the transverse web plates.

7.4.8 The ship's bottom shell plating is to be increased in thickness in way of the rudder horn. Where the horn plating is radiused into the shell plating, the radius at the shell connection is to be not less than:
r = (150 + 0,8L) mm.

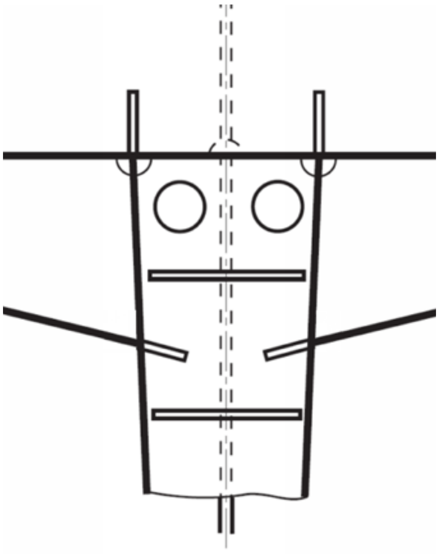

Figure 6.7.8 Rudder horn integration

7.4.9 The bending moments and shear forces are to be determined by direct calculations.

7.4.10 The scantlings of the rudder horn are to be not less than those required by *Table 6.7.5 Rudder horn scantlings*:

Table 6.7.5 Rudder horn scantlings

Item, *see Figure 6.7.8 Rudder horn*	Minimum requirement
Section modulus about the horizontal (x)-axis, Z_x	$Z_x = \dfrac{M_b k}{67}$ cm^3
Rudder horn plating	$t = 2{,}4\sqrt{Lk}$ mm
Symbols	
M_b = bending moment, in Nm, at the section considered. k = as defined in *Table 13.2.1 Rudder material factor, k*	

7.4.11 The rudder horn is to be dimensioned such that the stresses do not exceed the permissible stresses given in *Table 6.7.6 Permissible stresses for rudder horns*.

Table 6.7.6 Permissible stresses for rudder horns

Mode	Permissible stress
(1) Shear stress	$\dfrac{48}{k}$ N/mm^2
(2) Equivalent stress	$\dfrac{120}{k}$ N/mm^2

Symbols

σ_e = equivalent stress

$= \sqrt{\sigma_b{}^2 + 3\left(\tau^2 + \tau_T{}^2\right)}$ N/mm^2

σ_b = bending stress

$= \dfrac{M_b}{Z_x}$ N/mm^2

τ = shear stress

$= \dfrac{B_1}{A_h}$ N/mm^2

B_1 = supporting force in the pintle bearing, in N

A_h = effective shear area of rudder horn in y-direction, in mm^2

τ_T = torsional stress

$= \dfrac{M_T 10^3}{2 A_T t_h}$ N/mm^2

M_T = torsional moment at the section considered, in Nm

A_T = area in the horizontal section enclosed by the rudder horn, in mm^2

t_h = plate thickness of rudder horn, in mm

k = as defined in *Table 13.2.1 Rudder material factor, k*

7.5 Rudder trunks

7.5.1 Rudder trunks extending above or below the stern frame are to be constructed of steel of a weldable quality with a carbon content not exceeding 0,23 per cent on ladle analysis and a carbon equivalent CEQ not exceeding 0,41.

7.5.2 Plating materials for rudder trunks are in general not to be of lower grades than those corresponding to Class II as defined in *Table 2.2.2 Steel grades*.

7.5.3 The weld at the connection between the rudder trunk and the shell or the bottom of the skeg is to be full penetration.

7.5.4 The fillet shoulder radius, r, of webs connected to the rudder trunk *see Figure 6.7.9 Rudder trunk fillet shoulder radii*, are to be as large as practicable and are in no case to be less than:

r = 60 mm when $\sigma_b \geq \frac{40}{k}$ N/mm²

r = the greater of $0{,}1d_c$, and 30 mm when $\sigma_b < \frac{40}{k}$ N/mm²

where

d_c = rudder stock diameter as defined in *Table 13.2.4 Rudder stock diameter*

σ_b = bending stress in the rudder trunk, in N/mm²

k = as defined in *Table 13.2.1 Rudder material factor, k*

The radius may be obtained by grinding. If disk grinding is carried out, score marks are to be avoided in the direction of the weld. The radius is to be checked with a template for accuracy. At least four profiles are to be checked. A report is to be submitted to the Surveyor.

7.5.5 Rudder trunks comprising of materials other than steel will be specially considered.

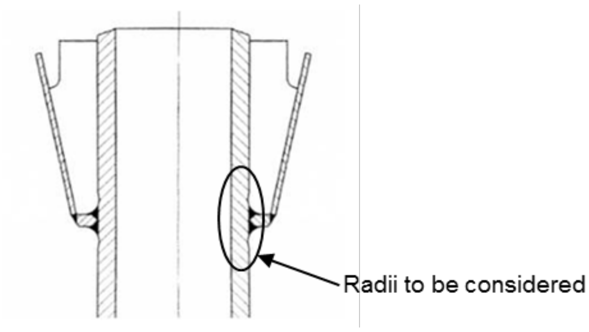

Figure 6.7.9 Rudder trunk fillet shoulder radii

7.5.6 Where the rudder stock is arranged in such a way that it will impose forces on the rudder trunk, the scantlings of the trunk are to be as follows:

(a) the equivalent stress due to bending and shear is not exceed $0{,}35\sigma$,

(b) the bending stress of fabricated rudder trunks is to be less than $\frac{80}{k}$ N/mm^2

where

σ_b = bending stress in the rudder trunk, in N/mm^2

k = as defined in *Table 13.2.1 Rudder material factor, k* but is not to be taken less than 0,7

σ = minimum specified yield stress, in N/mm^2

For calculation of bending stress, the span to be considered is the distance between the mid-height of the lower rudder stock bearing and the point where the trunk is clamped into the shell or the bottom of the skeg.

Existing sub-Sections *7.4* to *7.7* have been renumbered *7.6* to *7.9.*

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